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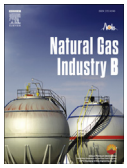

Research article

Strategic analysis on establishing a natural gas trading hub in China

Tong Xiaoguang [a,b,*], Zheng Jiong [a,b], Fang Bo [b]

[a] China University of Petroleum, Beijing 102249, China
[b] China National Oil & Gas Exploration and Development Corporation, CNPC, Beijing 100034, China

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Abstract

Since 2010, the LNG importing price premium in the Asia–Pacific markets has become increasingly high, generating great effects on the economic development in China. In addition, the natural gas dependence degree is expanding continuously, making it extremely urgent to establish a natural gas trading hub in China, with the aim to ensure national energy security, to gain the pricing power, and to build the regional benchmark prices. Through a comparative analysis of internal strength/weakness and external competitiveness, we concluded that with intensively-issued supporting policies on the natural gas sector, the initiation of spot and futures markets, the rapid growth of gas production and highly-improved infrastructures, as well as Shanghai's advantageous location, China has more advantages in establishing an Asian Natural Gas Trading Hub than other counties like Singapore, Japan and Malaysia. Moreover, based on the SWOT (strength, weakness, opportunity and threat) and the marketization process analysis, the following strategies were presented: to impel the establishment of a natural gas trading hub depending on the gas supply condition, to follow the policies to complete the gas storage system, to form regional communities by taking comparative advantages, and to reinforce the marketization reform and regulation system establishment with foreign experiences for reference. This study rationalized the necessity and practicality of establishing a natural gas trading hub in China and will help China make a proper decision and find a periodical strategic path in this sector.

Keywords: China; Natural gas; Trading hub; Competitiveness; Strategic analysis; Execution; Import premium; Pricing mechanism; Decision-making support

With the development of China's national economy, the demand for energy (especially natural gas) has become increasingly great. Since 1993, the proportion of natural gas in China's total energy consumption has increased gradually. In 2013, China's apparent natural gas consumption was 1676×10^8 m^3 and ranked No. 3 in the world. It is predicted in the 12th *Five-year Plan for Natural Gas* (hereinafter referred to as "Plan") that, in 2015, China's natural gas demand will reach 2300×10^8 m^3, and the import volume will double that in 2013 and reach 935×10^8 m^3, and the dependence on imported natural gas will exceed 35%. The stability and economic efficiency of natural gas supply are very important in safeguarding China's energy security. The term "economic efficiency" refers to the price of natural gas supply, which is reflected in the reduction of natural gas importing price premium in the Asia–Pacific markets, the competition for the pricing power, and the settlement to the problem that the sales price is lower than the purchase price. The term "stability" refers to the situation that the natural gas supply can meet the conventional market demand and respond flexibly to a sudden change in supply-demand balance. Establishing a natural gas trading hub will be favorable for setting up a marketized trading platform and setting up a gas price mechanism which reflects the supply-demand balance in a real-time way, so as to ensure the "economic efficiency" and "stability" of natural gas supply, improve China's energy security and enhance China's pricing power for natural gas in the Asia–Pacific markets and even in the global market.

* Corresponding author. China University of Petroleum, Beijing 102249, China.
E-mail address: tongxg@cnpcint.com (X. Tong).
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At the entity level, the so-called "natural gas trading hub" is the place where the physical goods transaction of natural gas from various sources (domestically-produced gas as well as imported pipeline gas and LNG) is carried out; at the financial level, it is the platform for e-commerce transaction of natural gas futures contract. Therefore, the natural gas trading hub is normally composed of spot market and futures market (as indicated in Fig. 1), between which the main difference is reflected in the delivery period [1]. As for the former, the delivery period is less than one week, the contract is reached by both parties involved in transaction directly through negotiation, and the price depends on the short-term supply-demand balance in the market; as for the latter, the delivery period is relatively long, and both parties involved in transaction agree to complete the delivery at a certain time in the future in accordance with the agreed price, quantity and quality. This mode combining the financial futures market with the physical spot market will not only make the pricing of natural gas more reasonable, but also help the traders to avoid and disperse the supply-demand risks and price risks. The natural gas trading hub mentioned in this paper is the integration of physical spot market and financial futures market, and may also be called a natural gas trading market.

At present, it has been proposed in the Plan to "study" the feasibility of establishing a national-level natural gas trading market. However, in China, the studies on spot transaction [2], futures transaction [3], market structure [4] and pricing mechanism [5] appear relatively fragmented, and the analysis on China's competitiveness in establishing a natural gas trading hub is also relatively inadequate. In foreign countries, the studies on market experience [1,6] and pricing mechanism [7–9] in Europe and the United States are relatively adequate, but it is still necessary to consider China's actual situation. As to natural gas spot and futures markets, this paper has systematically set forth the necessity for the establishment, and summarized the conditions for establishing natural gas trading hub in China by borrowing ideas from the market experience in Europe and the United States, analyzed China's internal strength/weakness and external competitiveness, sorted out the strategic options, and put forth the staged implementation path.

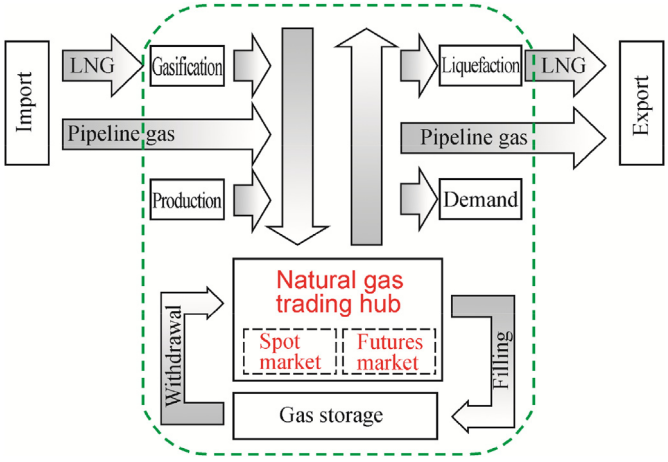

Fig. 1. Schematic diagram of the structure of natural gas trading market.

1. Necessity for establishing a natural gas trading hub in China

In China, the price of imported LNG is linked with Japan Crude Cocktail ("JCC") price, and the price of domestically-produced gas is determined by adopting the netback market value method. On the one hand, the former is always higher owing to the fact that it is linked with the oil price, the latter is imperfect owing to the fact that it is just linked with the alternative energy, and then the difference between internal and external gas prices leads to the situation that the sales price of imported LNG is lower than the purchase price. On the other hand, it is difficult for the natural gas transaction to get adapted to the change in supply-demand balance owing to the adoption of medium/long-term contract. Therefore, the necessity for China to establish a natural gas trading hub is mainly reflected in two aspects, namely price and supply-demand balance. It is necessary to use the price to reflect the supply-demand balance and use the supply-demand balance to form the price, so as to promote the sound development of natural gas markets.

1.1. The necessity of price

1.1.1. To reduce natural gas importing price premium in Asia–Pacific markets

North America, West Europe and *Asia–Pacific regions* are the main regional natural gas consumption markets in the world. Comparison of their prices (Fig. 2) reveals that, in January–July in 2013, the average gas price was US$3.71, US$10.74 and US$16.63 per 10^6 Btu (British thermal unit, 1 Btu ≈ 1055 J, the same below) respectively. Compared with that in North America, the price premium in Asia–Pacific markets is obvious, and the price difference has increased from 2.5 times in 2010 to 6 times in 2012. In addition, the gas price in Asia–Pacific markets has also increased continuously owing to the increased oil price (for example, the price in 2012 was increased by US$1.72/$10^6$ Btu compared with that over the same period in the previous year), but the gas price in Europe and the United States has basically remained unchanged (in 2012, the Henry Hub gas price (USA) was only reduced by US$1.25/$10^6$ Btu compared with that in 2011, and the NBP gas price (UK) was only increased by US$0.075/$10^6$ Btu compared with that in 2011). As a result, in 2013, China had to pay additional US$1.577 billion for the import of 245×10^8 m^3 LNG [10] (Only the additional amount paid owing to the increase in imported gas price in Asia–Pacific markets in 2012 was calculated, without considering the inflation factor), namely about US$100 was additionally paid for every ton of imported LNG, which has adversely affected the economic efficiency of China's natural gas markets.

The importing price premium of natural gas in Asia–Pacific markets may be reduced and even eliminated by establishing the natural gas trading hub. Since the price

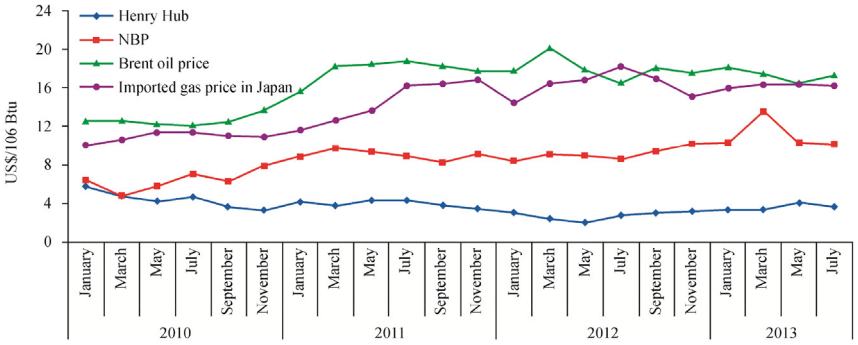

Fig. 2. Natural gas price in North America, West Europe and Asia–Pacific regions. Note: The data was sourced from Wood Mackenzie Global Gas Database

formed through spot transaction reflects the fair judgment on the value of natural gas in the market and the price formed through futures transaction reflects the medium/long-term prediction on the value of natural gas in the market, the two prices will interact and jointly decide the trading price and market trend of natural gas, so that the benchmark price for natural gas will be formed in China and even the Asia–Pacific regions. Therefore, establishment of the natural gas trading hub will play an important role in imparting price signals, guiding price reduction, reducing the importing price premium, and gaining the pricing power for natural gas.

1.1.2. To impel the pricing mechanism reform in China

In China, different pricing mechanisms are adopted for natural gas from different sources. Domestic gas is linked with fuel oil and liquefied petroleum gas on the basis of the netback market value method. The imported LNG is linked with the JCC price, and the imported pipeline gas is subject to the government-prescribed price based on "bilateral monopoly" [8]. The different pricing mechanisms have led to the unsmooth connection between domestically-produced gas price and imported gas price, so it is necessary to intensify the marketization reform on pricing mechanism and rectify the natural gas price system in China.

In Europe, the traditional gas pricing mechanism is linked with the price of crude oil. With the establishment of trading hubs in several countries (such as NBP in UK, TTF in Netherlands, NCG and Gaspool in Germany, and Zeebrugge in Belgium), the users, dealers and importers of natural gas have found that the spot gas price responds sensitively to the change in supply-demand balance, which can better reflect the market value and better meet their own interests. As a result, the mixed pricing mechanism which takes the linkage with oil price as a primary mode and takes the linkage with spot gas price as an auxiliary mode is finally formed [7,11,12]. Over the past five years, the proportion of natural gas consumption which is linked with gas price has increased from 16% to 47% [8,9] (Fig. 3). It can be said that, the establishment and development of a natural gas trading hub is the catalyst for the reform on the pricing mechanism in Europe. The establishment of a natural gas trading hub will also be favorable for China to intensify the reform on natural gas pricing mechanism and set up the unified pricing mechanism in which the prices of natural gas from different sources are mutually related and effectively interacted.

1.1.3. To settle the problem that the sales price is lower than the purchase price

The imported LNG has to be sold at the price of pipeline gas after being gasified and filled into pipeline, but the sales price of pipeline gas in China is lower than the import price of LNG. Therefore, some areas encounter the problem that the sales price of LNG is lower than the import price. Taking Jiangsu Province as an example, of the gate price of natural gas, the inventory part is US$11.1/10^6 Btu, and the incremental part is US$15.1/10^6 Btu; the data from Wood Mackenzie indicates that, however, the Rudong Receiving Station in Jiangsu imported LNG from Qatar at the price of US$18.8/10^6 Btu in 2013, which means that US$2.3–7.7 will be lost for every 1×10^6 Btu of natural gas sold. The root cause of the problem that the sales price of LNG is lower than the purchase price is the difference in pricing mechanism between imported gas and domestically-produced gas pricing mechanism. Therefore, it is necessary to establish the natural gas trading hub, so as to link the import price of natural gas in Asia–Pacific markets with gas price, set up the natural gas pricing mechanism which can reflect the supply-demand balance in markets, normalize the price relationship between imported gas and domestically-produced gas, and settle the problem that the sales price of LNG is lower than the purchase price.

1.2. The necessity of supply-demand balance

1.2.1. To reflect the market demand under normal circumstances

At present, the production capacity of LNG liquefaction plants in China has been excessively constructed and a lot of projects have been initiated simultaneously, so the supply fails to truly reflect the market demand. According to the data from the ICIS database, by May 2013, there had been more than 50 natural gas liquefaction plants in operation in China, with total capacity reaching 2300×10^4 m^3/d. In addition, more than 60 natural gas liquefaction plants were under construction, with the additional LNG production capacity reaching 4000×10^4 m^3/d. The excessive construction of natural gas

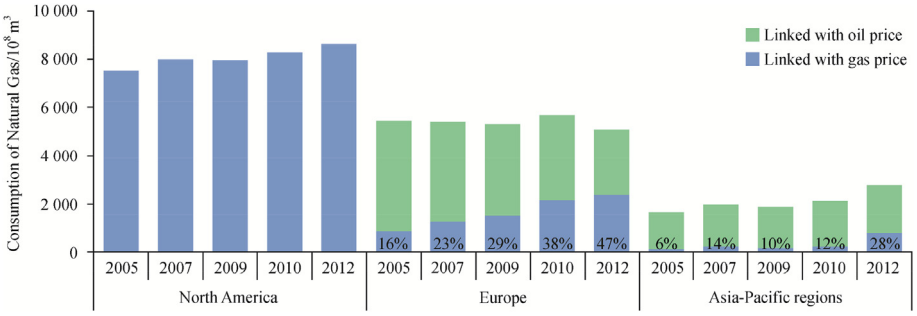

Fig. 3. Proportion of consumption of natural gas linked with gas price in North America, West Europe and Asia–Pacific regions.

liquefaction plants will lead to the short supply of raw materials, and also intensify the competition and reduce the operation efficiency of natural gas liquefaction plants in China. In 2012, the operating rate of most enterprises was less than 70%, and the average production load of the top-10 enterprises with respect to LNG output was only 45%. The establishment of the natural gas trading hub will enable the natural gas suppliers and end-consumers to predict the supply-demand balance in the future on the basis of futures price, so as to guide the production and import of natural gas, adjust the consumption by end users, stabilize the supply-demand balance in markets, and realize the orderly production in enterprises.

1.2.2. To meet the needs of demand change under special circumstances

In China, the annually-renewed medium/long-term transaction contracts for natural gas transaction, the fixed gas supply, and the limit of maximum gas supply cannot meet the needs of the rapid development of markets, the sharp increase of users, and the emergent demand change under different seasons, climates and supply conditions. However, establishing a natural gas trading hub and implementing spot transaction will help settle this problem, meet the special demand under the conditions such as climatic change (summer and winter), natural disasters and short supply of alternative fuel, impel the effective allocation of resources, and ensure energy security. In addition, establishing a natural gas trading hub will also be favorable for the government, natural gas production enterprises, natural gas transportation enterprises, urban gas companies and large industrial users to invest in gas storages, so as to provide the infrastructure guarantee for flexible peak modulation.

In addition to price and supply-demand balance, establishing a natural gas trading hub will also enable the whole society to understand the value of natural gas, increase the trading volume and consumption of natural gas, and reduce the emission of greenhouse gas and atmospheric pollutants such as SO_2 and dust. Under the condition of equivalent heating value, the quantity of CO_2, SO_2 and dust emitted from natural gas combustion is only 57%, 1/700 and 1/1478 of that emitted from coal combustion, which will help achieve the goal proposed by China to "reduce the CO_2 emission per unit GDP by 40%–45% by 2020 compared with that in 2005" and will also help reduce the damage to human health and ecological environment caused by the total suspended particles and SO_2 in the atmosphere. In addition, the main goal for energy structure optimization has also been proposed in the Plan, namely "to increase the proportion of natural gas in primary energy consumption to 7.5%". Establishing a natural gas trading hub can promote the development of natural gas market, push ahead the optimization and adjustment of energy structure in China, and set up the clean energy consumption system in which natural gas plays the leading role.

2. Analysis on the competence in establishing a regional natural gas trading hub

In order to gain the pricing power for natural gas and seize the opportunity in setting up the regional benchmark price, main port cities in the Asia–Pacific region have planned to establish natural gas trading hubs during 2014–2020. For example, Singapore takes establishing a global natural gas trading hub as its development strategy in the next five years; the Japanese government announced that it would launch the first LNG futures contract in the world in Tokyo Commodities Exchange before 2014; and Malaysia has invested US$1.3 billion in the construction of Pengerang LNG terminal, aiming to establish an LNG trading hub for Asia in 2020. Therefore, the pressing external situations have forced China to accelerate the establishment of natural gas trading hub. By summarizing relevant researches [1,6,13], we believe that, in order to establish the natural gas trading hub, we should get well prepared in three aspects: intrinsic base, hardware and software (Table 1). Intrinsic base includes mature gas spot and futures trading platforms, and abundant gas supply; hardware includes good port and international transport locations, complete infrastructures, and international energy companies

Table 1
Conditions for establishing a natural gas trading hub.

Conditions	Requirements
Intrinsic base	1. Mature gas spot and futures trading platforms
	2. Abundant gas supply
Hardware	3. Good ports and international transport locations
	4. Complete infrastructures
	5. International energy companies and financial companies
Software	6. Free and open market structures
	7. Complete legal and regulatory systems

and financial companies; software includes free and open market structures and complete legal and regulatory systems. In view of these three conditions, we analyzed the feasibility to establish a regional natural gas trading hub in China from a perspective of its internal advantages and disadvantages as well as external competence.

2.1. Advantages and disadvantages of China

2.1.1. Requirements on intrinsic base are satisfied as a whole

2.1.1.1. The spot and futures markets have started up. Gas spot transaction is in the startup stage in China, and was launched for the first time in Shanghai Petroleum Exchange (SPEX) on December 17, 2010. From 2012 till now, SPEX has successively launched gas spot transactions four times (Table 2), with the first-day trading volume increased from less than 4000 t to 11.18×10^4 t and the transaction scale developed rapidly. In addition, a lot of exploration has been made in the transportation mode for spot transactions. The transportation mode has been changed from tanker transport to CNPC long-distance pipeline delivery, and the delivery areas have also expanded from the Yangtze River Delta regions (hereinafter referred to as "Yangtze Delta") to the Pearl River Delta regions (hereinafter referred to as "Pearl Delta") where the natural gas is in short supply, with the transaction modes upgraded continuously.

Though gas futures markets have not been fully formed in China, they are in the bud. On August 22, 2013, Shanghai Free Trade Zone was set up, promoting the intermediary or FOB trade business and bulk commodity circulation and providing the platform support for gas transaction. On November 22, 2013, Shanghai International Energy Trading Hub was established, with the business scope covering the organization of transactions, settlement and delivery of energy (such as natural gas) derivatives. As a result, the establishment of energy futures market will be promoted, and its function such as risk management, price identification and supply-demand adjustment will be brought into full play, which indicates that the a key step has been made for gas futures transactions.

2.1.1.2. Gas supply is abundant and rapidly increased. Gas supply in China mainly comes from domestically-produced gas, imported pipeline gas and imported LNG. According to BP Global Energy Data [10] (Fig. 4), total natural gas supply in China has increased from 847×10^8 m^3 in 2008 to 1661×10^8 m^3 in 2013, with the compound annual growth rate reaching 14.4%. According to IEA forecasts [1], in 2015, the supply of domestically-produced gas, imported pipeline gas and imported LNG in China will respectively reach up to 1700×10^8, 450×10^8 and 450×10^8 m^3, with a total supply being 2600×10^8 m^3, doubled compared with that in 2010, which indicates that the goal "consumption of 2300×10^8 m^3 in 2015" put forth by the government can be achieved. On the other hand, China enjoys huge development potential of unconventional natural gas. It is expected that, the output of coalbed methane (CBM) and shale gas in China will reach up to 400×10^8 m^3 in 2020, accounting for 15.4% of its domestically-produced gas [14]. The abundant and rapidly-increased natural gas supply has laid a solid intrinsic base for establishing a trading hub.

2.1.2. Requirements on hardware conditions are basically satisfied

2.1.2.1. Shanghai enjoys obvious location advantages. Good ports, excellent international transport locations as well as international energy companies and financial companies are hardware for establishing a natural gas trading hub. In these aspects, Shanghai enjoys obvious advantages, which are mainly reflected in the following five aspects: ① The geographical location of Shanghai is excellent, the main LNG markets in the world are accessible through marine transportation, and Shanghai is an important port city in Asia–Pacific areas; ② Shanghai is addressing itself to building the international financial center equipped with complete facilities and home to financial talents with rich management experiences, which will be favorable for establishing financial futures markets; ③ Shanghai has complete LNG receiving stations and facilities. The receiving station near Yangshan deep-water port is favorable for international buyers to complete the delivery, and Wuhaogou LNG station is favorable for domestic buyers to complete the delivery; ④ Shanghai is the only city in China where connection between the gas from West-East Gas Pipeline, the gas from Sichuan-East Gas Pipeline and the imported LNG can be achieved and natural gas can be transported conveniently; ⑤ The market environment in Shanghai is favorable. Energy consumption is concentrated, and the Yangtze River Delta where Shanghai is located is an important heavy chemical industrial base. The above-mentioned geographical advantages of

Table 2
Gas spot transaction in Shanghai petroleum exchange.

Transaction	Launch time	Window period/month	Total trading volume/10^8 m^3	First-day trading volume/10^4 t	Transportation mode	Delivery area
Meeting the demand during peak period in summer	July 2, 2012	3	1	0.396	Tanker	Yangtze Delta
Meeting the demand during peak period in winter	December 1, 2012	3	3	–	Pipeline	Yangtze Delta
Meeting the demand during peak period in summer	August 13, 2013	4.5	–	4.148	Pipeline	Pearl Delta
Meeting the demand during peak period in winter	December 5, 2013	–	–	11.180	Pipeline	Pearl Delta

Note: The information given in this table is based on the data published on the website of Shanghai Petroleum Exchange.

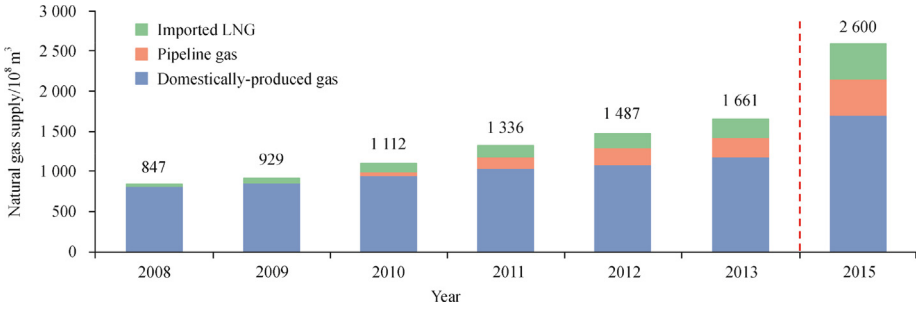

Fig. 4. Change in gas supply in China and prediction for 2015.

Shanghai will to a great extent promote the establishment and development of a natural gas trading hub.

2.1.2.2. Gas storages in infrastructures are insufficient. Insufficient gas storage capacity and incomplete storage system are the weakness of China in the aspect of natural gas infrastructures. In 2013, China's gas storage capacity and volume account for only 0.2% and 0.3% of the global total, respectively. In the United States, these two figures reach 29.8% and 29.7% respectively (according to the data from Wood Mackenzie Gas Tool Database). It is also pointed in the Plan that "at present, the working volume of gas storages accounts for only 1.7% of the total consumption, far less than 12% of the average level in the world", so the construction of gas storages should be accelerated. With respect to storage system, most of the gas storages currently constructed in China are the gas storages of strategic significance and are located in West China. Since they are relatively far away from users, the peak-modulating role can't be brought into full play, so the peak-modulating and commercial gas storages are seriously insufficient, thus a natural gas storage system has to be set up and improved.

In China, the other infrastructures of natural gas markets are relatively complete. Regarding LNG receiving stations, there are seven receiving stations already constructed, nine under construction and eight to be constructed in China (according to the data from Wood Mackenzie LNG Tool Database). Regarding transnational pipelines, China has basically constructed the Kazakhstan–China oil and gas pipeline and Central Asia natural gas pipeline in the northwest, the Russia–China crude oil pipeline in the northeast, the Myanmar–China crude oil pipeline in the southwest and four major offshore oil and gas import passages, thus the gas supply conditions which originally depended on the Strait of Malacca have been gradually changed to the diversified gas supply composed of four major oil & gas strategic passages. Regarding domestic pipelines, China has constructed the national-level pipeline network which takes the West-East Gas Pipeline, Sichuan-East Gas Pipeline, West-East Gas Pipeline II (western section), Shanxi-Beijing Pipeline, Zhongxian-Wuhan Pipeline and Yongqing-Tangshan-Qinghuangdao Pipeline as backbones and take Lanzhou-Yinchuan Pipeline, Huaiyang-Zhongwu Pipeline and Shijiazhuang-Nanjing Pipeline as connecting lines, thus the national gas supply network has been basically formed. Therefore, except for gas storages, the natural gas infrastructures in China are of good conditions and can basically meet the requirements on hardware for establishing a trading hub.

2.1.3. Software conditions are relatively insufficient

2.1.3.1. Market structure reform is not yet fully implemented. Experiences from Europe and the United States reveal that, establishing a natural gas trading hub is almost always accompanied with the change in contract mode and pricing mode. At present, China has initiated the marketization process, but the process is not fully implemented. With respect to gas pricing mechanism reform, China started to adopt the "netback market value method" for gas pricing in June 2013, basically realized the change from government-regulated "cost plus method" to pricing mechanism linked with alternative energy (fuel oil and liquefied petroleum gas), and adjusted the price management from ex-factory delivery to station delivery. However, the deficiency is that the price adjustment frequency at station is once a year, which can't quickly and effectively reflect the fluctuation of markets and the change in supply-demand balance. In addition, the price of the real competitor for natural gas in power generation field, namely coal, is not considered, so the natural gas price reform has not been fully implemented [15]. Regarding contract mode, SPEX has launched the LNG spot transaction, but the trading volume is relatively low. The marketization reform should be intensified and driven continuously in light of the current conditions and development stage of natural gas markets in China.

2.1.3.2. The legal and regulatory system is incomplete. At the current stage, China has not issued laws relating to natural gas. Also the market administration power is distributed among different government departments and agencies, and no independent natural gas regulatory body has been formed. Therefore, it is necessary to borrow ideas from the development experiences of Europe and the United States. The federal government of the United States issued the first natural gas regulation (namely the *Natural Gas Act*) in 1938, and then issued the *Natural Gas Policy Act* (1978), the *Act No. 436* (1985), the *Natural Gas Wellhead Decontrol Act* (1989) and the *Act No. 636* (1992), so as to gradually drive the development of natural gas markets; the establishment of Federal

Power Commission ("FPC") (1938) and Federal Energy Resource Commission ("FERC") (1978) of the United States has ensured to a great extent the normalized and orderly development of markets. The *Petroleum and Natural Gas Enterprise Act* promulgated by UK in 1982 indicated the first step of marketization reform. The subsequent development of natural gas market was realized under the administration of the laws and regulations such as the *Natural Gas Act* (1986), the *90:10 Regulations* (1990) the *Natural Gas Act* (1995) and the *Pipeline Code* (1996) as well as the bodies such as the Office of Gas Supply (Ofgas, 1986) and the Office of Gas and Electricity Markets (Ofgem, 2000). It can be said that, the establishment and development of a natural gas trading market is always accompanied by the improvement of laws and regulations as well as the standardization of markets, and this is the requirements on software conditions for the development of natural gas markets.

2.2. Competence of other countries

After identifying the internal advantages and disadvantages of China, let's look at the main countries (Singapore, Japan and Malaysia) in Asia–Pacific markets which also plan to establish the natural gas trading hub, and compare the comparative advantages and disadvantages of each country. On the basis of the following seven conditions, the four countries in the Asia–Pacific region are scored (Table 3). The score falls into four levels: "+++" means obvious competitive advantages, "+" means certain advantages, "−" means certain disadvantages, "−−−" means obvious disadvantages, and these levels are indicated by 8, 6, 4 and 2 points respectively. Through the calculation of weight (to be determined by using the Delphi method) and the drawing of bubble diagram (Fig. 5), the abscissa in Fig. 5 indicates the degree to which the requirements on hardware conditions are met; the ordinate indicates the degree to which the requirements on software conditions are met; the size of bubble indicates the degree to which the requirements on intrinsic base are met; and the larger bubble indicates the higher degree to which the requirements for establishing a natural gas market are met and the more obvious late-development advantages. The three competitors with the highest score are detailed as follows.

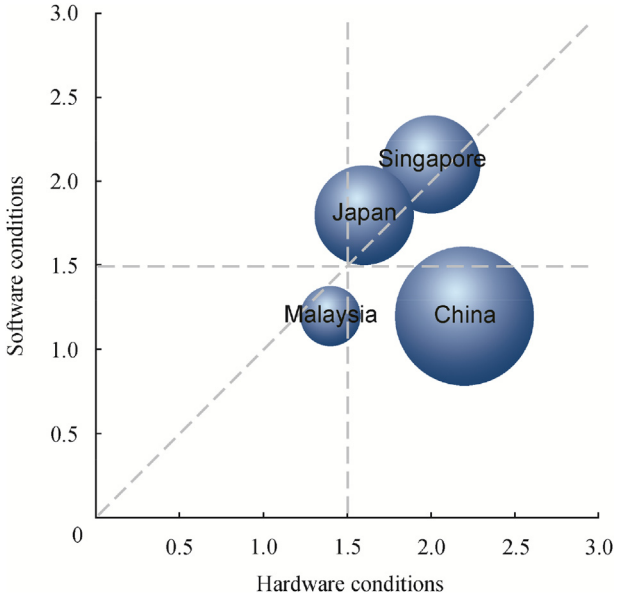

Fig. 5. Analysis on the competence of the four countries in Asia–Pacific region in establishing a natural gas hub.

2.2.1. Software conditions of Singapore are excellent, but the medium/long-term competence is limited

Singapore enjoys outstanding advantages in the aspect of software conditions. For example, the free and open market structure is excellent. The *Natural Gas Law* promulgated in 2001 has clearly separated the transmission, distribution and sales by appointing the Energy Market Authority (EMA) to take charge of regulation and appointing the Ministry of Trade and Industry (MTI) to take charge of energy pricing. And the *Gas Network Code* promulgated in 2008 has further clarified the specific management framework for third-party accessibility to fuel gas pipe network. In the aspect of hardware conditions, the infrastructures in Singapore are insufficient. There is only one transnational natural gas pipeline (used to import the pipeline gas from Malaysia) and one LNG receiving station (Jurong Island LNG Receiving Station), and the capacity of LNG receiving station after being expanded in 2014 is only 900×10^4 t (equivalent to 125.1×10^8 m^3), slightly higher than its domestic market scale (100×10^8 m^3), so the capacity available for natural gas trading is very limited. In the aspect of intrinsic base, the disadvantages of Singapore

Table 3
Analysis on the competence of the four countries in Asia–Pacific region in establishing a natural gas hub.

	Conditions for establishment	Weight	China	Singapore	Malaysia	Japan
Intrinsic base	Spot and futures trading platforms for natural gas	20%	+	+++	−−−	+++
	Abundant natural gas supply	20%	+++	−−−	−	−−−
Hard conditions	Good ports and excellent international transportation location	10%	+++	+++	+	+
	Complete infrastructures	10%	+	−	−−−	−−−
	International energy companies and financial companies	10%	+++	+++	−	+
Soft conditions	Free and open market structures	15%	−	+++	−	+++
	Complete law and regulation systems	15%	−	+	−	−

Note: The basis for score relating to competence is not detailed owing to the limited length of this paper. For further information, please contact the authors directly.

are obvious. Its market scale is small, and its output, demand, gasification capacity and gas storage capacity are weaker than that of China and Japan, so its medium/long-term competence is restricted to a certain extent.

2.2.2. Japan only aims to establish the LNG futures market

The Japanese government has planned to launch the LNG futures transaction in 2014 and form the long-term virtual price for LNG on the basis of the futures transaction. Aiming to only establish the financial futures market is favorable for Japan to make best use of the advantages and bypass the disadvantages. Advantages mainly include that the import volume of natural gas is large. Japan is the largest LNG buyer in the world, with the import volume of LNG increased greatly and continuously after the Fukushima Event. The LNG pricing mechanism linked with JCC enables Japan to take a favorable position in gas pricing in the Asia–Pacific region, and the developed and mature financial market enables Japan to have the well-operated bulk commodity exchange. Disadvantages include that almost all the demand for natural gas has to be met by imported gas. The absence of domestically-produced gas makes Japan unable to hedge against the fluctuation of international natural gas price and lack bargaining power. In addition, its monopolized electrical power market will hinder new entrants to a certain extent, and the reform progresses slowly.

2.2.3. China enjoys outstanding late-development advantages

Though Singapore keeps one step ahead in the aspect of software conditions, China has also its own comparative advantages, which are mainly reflected in the following three aspects: ① In the aspect of supply, the dependence of Singapore and Japan on imported natural gas reaches 100%, while China enjoys diversified gas sources, including domestically-produced gas, imported pipeline gas and imported LNG; ② In the aspect of gas storage capacity, according to the data from Wood Mackenzie Global Gas Database, Japan currently enjoys the largest gas storage capacity (216×10^8 m^3 in 2013), but in 2015, China will overtake Japan, with the gas storage capacity being 480×10^8 m^3; ③ In the aspect of construction of LNG receiving stations and pipelines, China is far ahead of other countries in Asia–Pacific region. Abundant natural gas supply, solid spot and futures trading platforms as well as mature LNG receiving stations and international/national pipelines are the important intrinsic base and hardware conditions for establishing a natural gas trading hub, which will bring strong advantages to China in medium and long term, and will also generate the eyepopping strength with the improvement in soft environment such as market structures and regulatory systems.

3. Strategic choice and implementation path for China to establish a natural gas trading hub

As for establishing a trading hub, the necessity is the internal factor, the external impendence is the external factor, and both the internal and external factors are urging China to list the establishing natural gas trading hub into agenda. China has the advantages such as abundant natural gas supply, already-launched spot and futures markets and obvious location advantages of Shanghai, but it has also the disadvantages such as the under-implemented marketization reform and incomplete law and regulation systems. By applying the SWOT analysis framework, we summarized the strength, weakness, opportunity and threat (Table 4) for establishing a natural gas trading hub in China, and then brought forth four development strategies, namely SO (make full use of opportunity and bring into full play the strength), WO (make full use of opportunity and avoid weakness), ST (bring into full play the strength and reduce threat) and WT (avoid weakness and reduce threat).

The static strategic options should be integrated with dynamic natural gas market evolution. After summarizing the development experiences in Europe and the United States, we believed that, the development of natural gas transaction market is accompanied with the evolution of market structures, contract modes, pricing modes and regulatory bodies. In general, as the marketized structure evolves, pricing modes will transit from government-regulated mode (cost plus method) to the oil price-linked mode (netback market value method) and finally to the gas price-linked mode. Contract modes will develop in the process of "long-term contract - short-term contract - spot transaction - futures transaction" (in some phases, several contract modes may exist simultaneously). Regulatory bodies will change in the process of

Table 4
SWOT analysis and strategic options for establishing a natural gas trading hub in China.

External environment	Internal strength (S)	Internal weakness (W)
	Startup of spot market and futures market	Insufficient investment in construction of gas storages
	Rapidly-increased natural gas supply	Insufficient market freedom
	Obvious location advantage of Shanghai	Inadequate laws
Opportunity (O)	Make full use of opportunity and bring into full play the strength (SO)	Make full use of opportunity and avoid the weakness (WO)
Active transaction in Asia–Pacific region Policy support in China	To impel the establishment of natural gas trading hub depending on the gas supply condition	To follow the policies to complete the gas storage system
Threat (T)	Bring into full play the strength and reduce the threat (ST)	Avoid weakness and reduce the threat (WT)
Countries like Singapore, Japan and Malaysia	To form the regional communities by taking comparative advantages	To reinforce the marketization reform and regulation system establishment with foreign experiences for reference

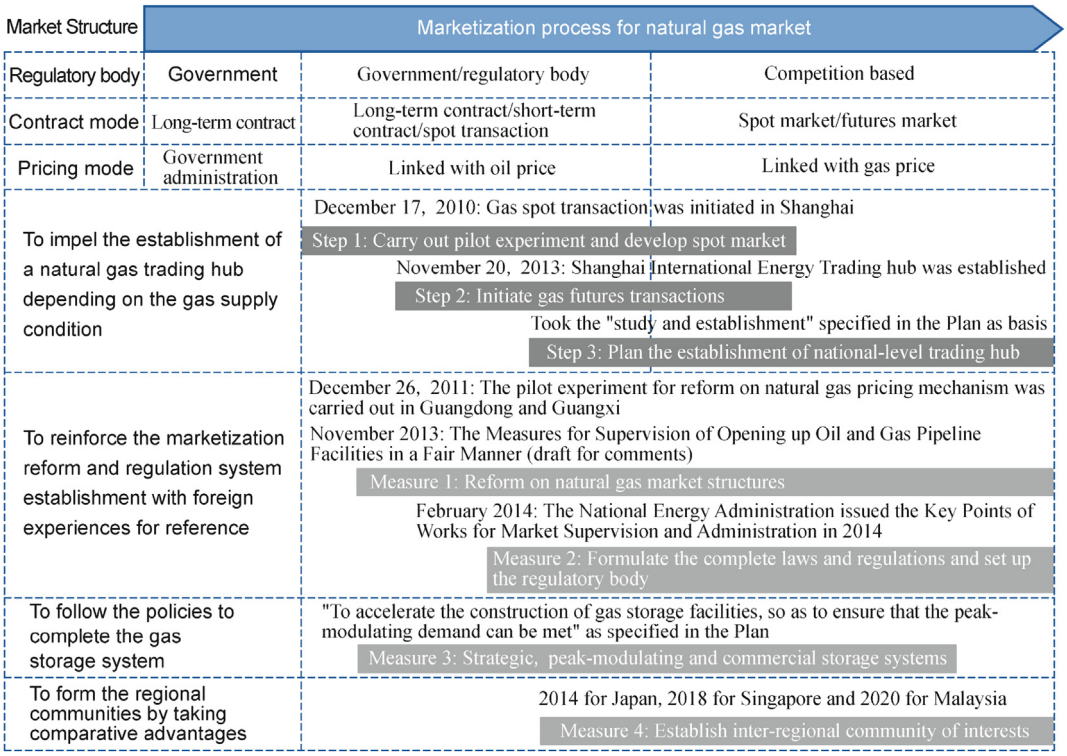

Fig. 6. Staged implementation path for establishing a natural gas trading hub in China.

"government - regulatory body - competition". Establishing a natural gas trading hub in China will also be accompanied with the marketization process, and different marketization reform tasks should be completed at different stages. We integrated the four development strategies and the staged market structure evolution, and brought forth the implementation path for establishing a natural gas trading hub in China as indicated in Fig. 6.

3.1. To impel the establishment of a natural gas trading hub depending on the gas supply conditions

For the purpose of establishing a trading hub, gas spot markets and futures markets should be set up in Shanghai on the basis of gas supply conditions and geographical features of gas transactions, and then be expanded to cover gas-rich regions. In addition, the implementation path "increase spot trading - initiate futures trading - strengthen regional cooperation - plan national-level trading hub" should be followed: ① Promote the development of spot transactions by taking the initiation of gas spot transaction in Shanghai in 2010 as an opportunity and taking the seasonal peak modulation as the cut-in point. This work will exist throughout the marketized development process; ② Promote the pilot experiment on futures transaction and harmonize the development of both spot and futures markets by taking the establishment of Shanghai International Energy Trading hub in 2013 as an opportunity. With the establishment and development of futures markets, the contract mode will be gradually changed to spot and futures contracts; ③ In light of the gas supply conditions and resource distribution in China, impel the market development in other areas where the conditions are satisfied (such as the Sichuan-Chongqing natural gas market which enjoys good resource base, high output, relatively complete gas supply infrastructures and mature gas transaction system, the Xinjiang natural gas market which takes Tarim, Karamay and Tuha Oil/Gas Fields as core, the Qinghai gas market which takes Shebei Gas Field as core, the Shaanxi, Gansu and Ningxia natural gas markets which take Sulige Gas Field and Jingbian Gas Field as core, the Northeast China gas market which takes Daqing Oilfield and Qingshen Gas Field as core and the Henan natural gas market which takes Zhongyuan Oilfield and Henan Oilfield as core) [2], harmonize the inter-regional natural gas transactions, and promote the bilateral and even multi-lateral natural gas transactions; ④ On the basis of the requirement "to study and establish national-level natural gas trading market" in the Plan, take the beginning of 13th Five-year Plan Period in 2016 as the starting point, and promote the establishment of a national-level natural gas trading hub.

3.2. To reinforce the marketization reform and regulation system establishment with foreign experiences for reference

We will promote the marketization reform by taking the policies given in June 2013 for gas price reform and the gas spot transaction carried out in Shanghai Petroleum Exchange in 2010 as starting point, and will realize the transition from oil price-linked pricing mechanism to gas price-linked pricing

mechanism, the transition from long-term contracts to short-term contracts and the transition to spot contracts and futures contracts by using the market evolution experiences in Europe and the United States for reference. This process should ensure the smooth transition of market structures, contract modes and pricing mechanism, and meet the present status and development of natural gas markets in China. With respect to the regulatory system, the *Key Points in Works for Market Regulation* for 2014 has raised the curtain on normalized market regulation. It is advised to establish the legal system which takes the *Natural Gas Law* as core, and enable the spot markets and futures markets to steadily develop within the legal framework; it is also advised to set up a special regulatory body for natural gas transactions (separately established or established together with power authority), formulate the rules and regulations for production, transportation, sales and consumption and harmonize the industrial standards relating to supply, demand, transportation, distribution, market admission, pricing mechanism, metering and billing of natural gas, so as to realize the unified regulation on natural gas markets.

3.3. To follow the policies to complete the gas storage system

Take the policy "to accelerate the construction of gas storage facilities, so as to ensure that the peak-modulating and emergent demand on natural gas can be met by the end of 12th Five-year Plan Period given in the Plan issued in 2011 as an opportunity, and urge the stakeholders to jointly complete the natural gas storage system: The government departments should increase the investment in constructing strategic or emergency gas storages in import passages and cities; gas production enterprises, gas supply enterprises, large industrial users and urban gas companies should construct commercial seasonal gas storages and peak-modulating gas storages; and third-party investment should be adopted to construct commercial storage facilities. Through the construction of storage systems, on the one hand, gas storage capacity will be increased; on the other hand, the concerted operation of strategic, seasonal, peak-modulating and commercial gas storages will be promoted, so as to lay an important hard foundation for the development of natural gas trading markets.

3.4. To form regional communities by taking comparative advantages

As for the establishment of regional communities, firstly, it is necessary to bring into full play the unique advantages of China (such as the diversified natural gas sources, strategic passages composed of both onshore and offshore pipelines, and abundant and rapidly-increased gas supply); secondly, it is necessary to strengthen international cooperation awareness, make efforts to establish the overall trading markets in Asia–Pacific region, and bring the comparative advantages of each country into full play (for example, Japan aims at the LNG futures markets and places focuses on the formulation of virtual price; Singapore aims to bring its role as a physical pivot into full play); thirdly, it is also necessary to actively join the relevant organizations such as Liquefied Natural Gas Import Country Group ("LNGIG") led by Japan and India, and bring into full play the geographical advantages of Asia–Pacific region as the largest LNG import region in the world, and jointly set up the regional communities of interests. The period of 2014–2020 is the time window when Japan, Singapore and Malaysia launch their natural gas trading markets. To initiate the work for establishing the regional communities of interests in such a period will be favorable for accurately determining the orientation of a natural gas trading hub in China and highlighting the advantages of China, and will also be favorable for comprehensively planning and promoting the regional natural gas trading hub.

4. Conclusions and recommendations

The establishment of a natural gas trading hub will play an important role in reducing the import premium, adjusting the supply-demand balance and optimizing the energy structures. China basically meets the requirements on intrinsic base and hardware conditions for establishing a regional natural gas trading hub, but it has relatively disadvantages in software conditions such as market structures and regulatory system. Through an analysis on the necessity, competence, SWOT and marketization evolution, the strategic options and implementation paths have been put forth. The conclusions and recommendations are given as follows.

1) With active gas transactions, Asia–Pacific region will overtake North America and become the largest gas consumption region in the world in 2018. The establishment of a natural gas trading hub is of great significance for the host country to safeguard its energy security, compete for the pricing power, take the lead in forming the regional benchmark price and realize smooth and orderly market development. As a result, countries like Singapore, Japan and Malaysia have competed with each other in this aspect. It is necessary for China to sort out its strength and weakness, determine the orientation on the basis of the regional vision and carry out the overall planning as soon as possible.
2) With respect to natural gas, the import premium imposed on China in comparison with North America has increased from 2.5 times in 2010 to 6 times in 2012. The increased gas price has forced China to pay additional US$1.577 billion for gas import in 2013, which has affected to a certain extent the development of its national economy. Establishing a trading hub will not only ensure the security and economic efficiency of natural gas supply, but also drive the reform of gas pricing mechanism, settle the problem that the sales price of LNG is lower than the purchase price, avoid the excessive construction of liquefaction plants, optimize and adjust the energy structure, and normalize the natural gas markets of China. Therefore,

it is necessary to list into agenda and promote the establishment of a natural gas trading hub.

3) In China, the supply of conventional and unconventional natural gas is abundant and rapidly increased, and the spot market and futures market have started up. Shanghai has five obvious location advantages. The construction of LNG receiving stations has been promoted rapidly, and the demand, gas supply, gas storage capacities and gasification capacity will be far greater than those in other countries in the Asia−Pacific region. Therefore, China enjoys obvious advantages in intrinsic base and hardware conditions for establishing a trading hub, and these advantages will be brought into full play in a medium and long term.
4) At the current stage, China should, by virtue of the supply conditions and resource endowment and in accordance with the four stages of "spot transaction - futures transaction - regional linkage - national-level trading hub", gradually promote the establishment of the natural gas trading hub. In this process, China should not only strengthen the hardware conditions and urge all stakeholders to intensify the construction of strategic, commercial and peak-modulating storage systems, but also strengthen the soft conditions, strengthen the building of law & regulation systems which take the *Natural Gas Law* as core, and drive the market structure reform involving contract modes and pricing modes. On the basis of both software and hardware conditions, China should, during the period of 2014−2020, strengthen the coordination on regional interests, and use the overall vision to push ahead the establishment of regional natural gas trading markets.

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